1. Herr Gardner's radio show is on 91.7 MHz every Saturday night. What is the wavelength of these waves?

$v = f\lambda$

3×10^8 m/s $= (91.7 \times 10^6\text{Hz})(\lambda)$

$\lambda = \dfrac{300,000,000}{91,700,000}$ meters $= \boxed{3.27\,meters}$

2. A guitar string has a length of 1.20 meters with a fundamental frequency of 250 Hz and a linear density of 5.5×10^{-4} kg/m. What is the tension of the string?

$v_{string} = \sqrt{\dfrac{tension(N)}{linear\ density(kg/m)}}$

$v_{string} = f\lambda$

therefore $\sqrt{\dfrac{tension(N)}{linear\ density(kg/m)}} = f\lambda$

$\sqrt{\dfrac{tension}{5.5 \times 10^{-4} kg/m}} = 250\text{Hz }(\lambda)$

$\sqrt{\dfrac{tension}{5.5 \times 10^{-4}}} = 250(\lambda)$

$\sqrt{tension} = \sqrt{5.5 \times 10^{-4}}(250)(\lambda)$

$\sqrt{tension} = 5.863\lambda$

$tension = 34.375\lambda^2$

We know that $\ell_{string} = \dfrac{1}{2}\lambda$. We can rearrange to get $\lambda = 2\ell_{string}$, so $\lambda = 2.4m$

Plugging that back in we get $tension = 34.375(2.4)^2$, and $tension = \boxed{198N}$

3. What is the length of a tube open at both ends with the same fundamental frequency as the guitar string from the previous problem? Assume the speed of sound is 340m/s.

$v = f\lambda$

$340m/s = 250\text{Hz}(\lambda)$

$\ell = \dfrac{1}{2}\lambda$, so $\lambda = 2\ell$

Plugging in λ, we get $340 = 250(2\ell)$, so $\boxed{\ell = 0.68m}$

4. A tuning fork of an unknown frequency produces 6 beats per second when sounded with a 440Hz tuning fork. The beat frequency is greater when the unknown fork is sounded with a 430 Hz tuning fork. What is the frequency of the unknown fork?

Remember that beats per second is calculated with the expression $|f_1 - f_2|$, where f_1 and f_2 are the two frequencies vibrating simultaneously.

We know $|f_{unknown} - 440\text{Hz}| = 6\text{Hz}$, so $f_{unknown} = 434\text{Hz}$ or 446Hz.

But since the beat frequency is greater with the 430Hz fork, then $f_{unknown}$ must be $\boxed{446Hz}$

FORMULAS:

The Wave Equation:

$$\boxed{v = f\lambda}$$

Velocity of Sound travelling through a string under tension(T):

$$\boxed{v = \sqrt{\frac{T}{linear\ density}}}$$

Frequency of any harmonic in a closed tube of length ℓ:

$$v = f\lambda$$

$$\ell = \frac{n}{4}\lambda, \text{ so } \lambda = \frac{4\ell}{n}$$

$$v = f\frac{4\ell}{n}, \text{ therefore } \boxed{f = \frac{nv}{4\ell}}$$

Frequency of any harmonic in an open tube of length ℓ:

$$v = f\lambda$$

$$\ell = \frac{n}{2}\lambda, \text{ so } \lambda = \frac{2\ell}{n}$$

$$v = f\frac{2\ell}{n}, \text{ therefore } \boxed{f = \frac{nv}{2\ell}}$$

Length of a string vibration at the third overtone:

$$\ell = \frac{n}{2}\lambda, \text{ so } \boxed{\ell = \frac{3}{2}\lambda}$$

5. The tension on the 1.6 meter long wire is 135.0 N. The wire has a total mass of 0.008kg. What is the frequency of the THIRD OVERTONE produced by the wire?

Linear Density: $\frac{0.008kg}{1.6m} = 0.005\text{kg/m}$

$$\sqrt{\frac{tension}{linear\ density}} = f\lambda$$

$$\sqrt{\frac{135N}{0.005kg/m}} = f\lambda$$

$\ell = \frac{n}{2}\lambda$, so for the third harmonic, $\ell = \frac{3}{2}\lambda$, so $\lambda = \frac{2}{3}\ell$

Plugging this in, we get $\sqrt{\frac{135N}{0.005kg/m}} = f(\frac{2}{3})(1.6m)$.

$164.317 = 1.067f$, therefore, $\boxed{\text{f} = 154.05Hz}$

6. What is the wavelength of the next harmonic produced by the 1.6 meter wire shown above?

   We know that $\ell = \frac{n}{2}\lambda$. Knowing that this is the fourth harmonic, the equation becomes $\ell = 2\lambda$.

   $\ell = 1.6m$, so $\boxed{\lambda = 0.8m}$.

7. What is the fundamental frequency of a 0.8 meter closed pipe?

   We know that for a closed pipe, $\ell = \frac{n}{4}\lambda$, so for the fundamental frequency, $\ell = \frac{1}{4}\lambda$.

   Plugging in ℓ as $0.8m$, we get $\lambda = 3.2m$.

   $v = f\lambda$

   $340m/s = f(3.2m)$, so $\boxed{\text{f} = 106.25Hz}$

8.

9. What is the fundamental frequency of a 0.8 meter open pipe?

   $\ell = \frac{n}{2}\lambda$, so $\lambda = 2\ell$. Substituting, we get $\lambda = 2(0.8m) = 1.6m$

   $v = f\lambda$

   $340m/s = f(1.6m)$

   $\boxed{\text{f} = 212.5Hz}$

10.

11.Write the electromagnetic spectrum starting from the longest wavelength.

   Radio Waves $\longrightarrow$ Microwaves $\longrightarrow$ Infared $\longrightarrow$ Visible Light $\longrightarrow$ UV $\longrightarrow$ X-Rays $\longrightarrow$ Gamma Rays

   Visible light: Red $\longrightarrow$ Orange $\longrightarrow$ Yellow $\longrightarrow$ Green $\longrightarrow$ Blue $\longrightarrow$ Violet